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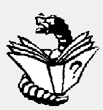

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Contents of this Journal

New Memberships, Membership Renewals

Membership form for new members, and details for payments by cheque for new and renewing members are on the last 2 pages of this journal and information for payment by credit card is given below.

If you are unsure when your renewal is due, contact

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Membership Payments by Credit Card

Internet payments by credit card (Visa, Mastercard, AMEX, Discover) can be made via the IRPS website

http://www.canberra.edu.au/irps

You do not need a PayPal account to use this method of payment

Go to the Home Page on our website (as above)
click on Membership, scroll down to the selection of buttons and click on the one that suits your membership.

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From the Editors

Dear Readers

As the third quarter of 2012 melts down, this issue of the IRPS Bulletin spotlights the calculus of nuclear power in the future global energy budget. Two recent reports are featured as a part of the conversation, as science and policy evolve in the context of climate change and other social and economic forces.

At this time, attention is also naturally directed to the 12th International Symposium on Radiation Physics, Rio de Janiero, Brazil (7th - 12th October, 2012). This triennial event is being hosted by our Society president, Odair Gonçalves and an enthusiastic and busy local-organizing committee. In a recent communication we learned there are at least 270 abstracts submitted from around 220 participants. In this issue we include for attendees the *Programme, Invited Talks and instructions for submitting manuscripts*. For those who are unable to attend, we will try to capture some of the content in future issues of this Bulletin, and note that the Proceedings will be carried as a special issue of the Elsevier journal Radiation Physics and Chemistry.

Finally, from time to time we like to re-print interesting or "classic" articles or reports. A recent perusal of The NBS Standard (January 9, 1980, Vol. 25, No. 1) the internal newsletter of what is today called the National Institute of Standards and Technology (NIST), turned up a travel diary written by John H Hubbell (1925 - 2007). Members will recall that John was a founder and beloved past president of the International Radiation Physics Society. He worked at NBS/NIST from 1950 to 1988, and was also past editor of Applied Radiation and Isotopes and consulting editor of Radiation Physics and Chemistry. In the scientific community, Hubbell is perhaps best known for his evaluations, computations and compilations of photon cross sections and attenuation (and energy-absorption) coefficients used in medicine, engineering and other disciplines. We hope you will enjoy a late 1970's trip to Russia through his eyes, and that you will consider suggesting similar classic articles or reminiscences to appear here in future issues.

John's Travel Diary is on the next 2 pages.

Larry Hudson & Ron Tosh

A Russian Diary

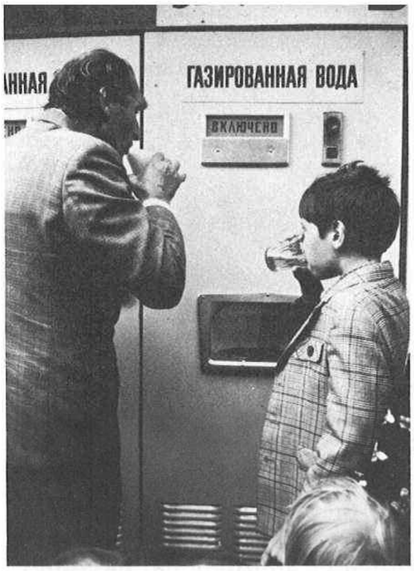
by John H. Hubbell

John H. Hubbell, Director of the X-Ray and Ionizing Radiation Data Center in the Radiation Physics Division, has recorded some observations of his visit to the USSR last August under the auspices of the NBS/USSR Academy of Sciences Memorandum on Cooperation. In a richly detailed journal submitted to the STANDARD, Hubbell described his arrival in Moscow, his first encounters with Russian hotels and restaurants, and sightseeing jaunts to some of the museum churches of the Kremlin, the Grand Kremlin Palace, Red Square, and the Cosmos Pavilion at VDNKh Exposition Park. In the excerpt here, Hubbell describes an unexpected meeting with Nobel laureate P.A. Cherenkov, arranged by physicist B.B. Govorkov.

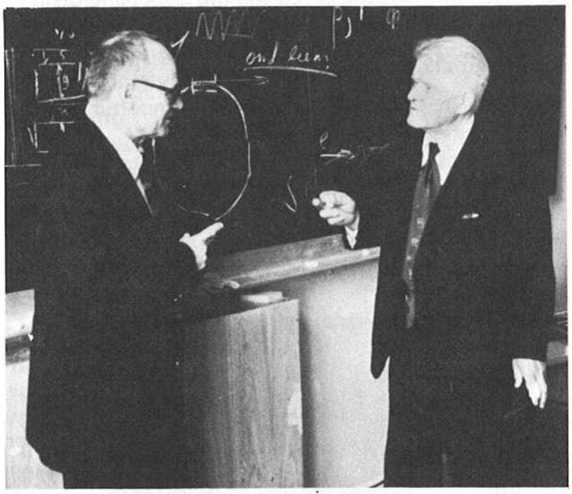
The first lab on my visitation list was Govorkov's own, the Photomeson Lab at Troitsk, some 40 kilometers south of Moscow. Govorkov met me at the hotel with his car and we duly arrived at what is also known as the "Academic City"... Govorkov had mentioned that I would be visiting the "laboratory of P.A. Cherenkov", but I had not fully realized what he meant. Inside the main building, up some stairs, down a hall and around a couple of corners, we stopped in front of a door, knocked, and were bid enter. Inside was a spry, white-haired short-statured man who turned out to be none other than the legendary Cherenkov himself.

"Cherenkov radiation" is used throughout the nuclear physics and high-energy accelerator experimental world as the basis for a variety of "Cherenkov detectors" of central importance to any such work. In this effect, charged particles traveling at velocities near the speed of light enter a clear material such as plastic or glass with a high refractive index, causing the effective speed of light to decrease proportionately, but with less effect on the massive charged particles. Hence we have particles in the material traveling "faster than the speed of light," resulting in a complaint, against this violation of Einstein's edict, in the form of the eerie blue light (Cherenkov

Continued on page 7



"Instead of public drinking fountains or 'Coke machines' in Moscow," writes John Hubbell, "there are soda-water vending machines distributed liberally around the tourist areas...No paper cups are available for these machines, but rather two or three common-use 8-oz. 'standard Russian' glasses associated with each machine...the right hand side of the inset shelf was a miniature dishwasher. One first inverted the glass and pressed down, upon which a spray of detergent (disinfectant?) liquid washed the inside of the glass. Then one placed the glass right side up on the left side of the shelf, put a 3-kopeck piece in the coin-slot on the face of the machine, and a measured amount of soda-water...spewed into the glass."



Photos by John Hubbell

John Hubbell and Nobel laureate P.A. Cherenkov at Lebedev Photomeson Laboratory in Troitsk near Moscow

Soyuz-Apollo replicas in the "Cosmos" Pavilion, VDNKh Exposition Park, Moscow

Russian Diary From page 5

radiation) seen, for example, around radioactive spent reactor fuel-rods deep in a swimming-pool storage facility.

Cherenkov had just turned 75 (July 15) and was still enjoying the glow of the jubilee and open-house celebration the Lab had organized in his honor. In 1958 he shared the Nobel Prize for Physics with fellow Russians I.Y. Tamm and I.M. Frank for his discovery of the "Cherenkov effect" while a graduate student at the USSR Academy of Sciences Institute of Physics in 1934.

In the process of introductions, I gave Cherenkov my NBS ("Radiation Theory Section") business card, upon which he reached in his desk drawer and pulled out his card, (Russian on one side, English on the other, as is customary), signed and dated it without my asking, and give it to me, knowing, I am sure, this to be the prize souvenir of my entire USSR exchange program. Cherenkov was not too comfortable using English, nor I Russian, but Govorkov and another of his colleagues, Lollii N. Shtarkov, were fluent in both and helpful in our conversation...

Cherenkov apologized that he would not be showing me around his laboratory facilities himself, due to his "regimen", but assured me I would be in good hands with Govorkov and Shtarkov, and asked us to return to his office at the end of our tour...

In Cherenkov's office, besides his desk, bookshelves and blackboard, was a small conference table, and on this table shortly after our return, materialized a steaming teapot, some small cups, a bowl of apples, a smaller bowl of wrapped pieces of candy, a bottle of cognac and some small, partly red-glass shot glasses. Of this we managed a modest lunch, finishing with a cognac toast.

Cherenkov, with a twinkle in his eye, complained that "the bargain was not complete" if I didn't drain my glass, since I had taken just a taste in deference to Cherenkov's Nobel Prize status and excused myself from the rest with, "At home I am a teetotaler." In the lunch conversation Cherenkov expressed considerable interest in American politics...The tea-party wound up with a picture-taking session, which all, including Cherenkov, seemed to enjoy.

Hubbell named Fellow by American Nuclear Society

John H. Hubbell, director of the X-Ray and Ionizing Radiation Data Center in the Center for Radiation Research, was recently elected as a Fellow in the American Nuclear Society. Hubbell was cited for "his acknowledged eminence in research on photon interactions and the evaluation and compilation of photon cross sections."

Hubbell came to NBS in 1951. He worked first in the crystal diffraction group on the measurement of powder diffraction patterns for the ASTM standard reference pattern file. He later worked for the thermodynamics section compiling data on the thermal properties of steam. Since being named director of the X-Ray and Ionizing Radiation Data Center in 1965, he has been involved in the collection and critical evaluation as well as the compilation of experimental and theoretical cross section data on x-rays and ionizing radiation.

Hubbell is the author or co-author of 52 publications. His best-known work was published as NSRDS-29, "Photon Cross Sections, Attenuation Coefficients, and Energy Absorption Coefficients from 10 keV to 100 GeV," which has been widely quoted and reproduced in the radiation field.

Born in Ann Arbor, Michigan, Hubbell received his B.S.E. in engineering physics in 1949 from the University of Michigan. He received his M.S. in physics, also from the University of Michigan, in 1950.

In addition to the American Nuclear Society, Hubbell is a member of the American Physical Society, the Philosophical Society of Washington, the Radiation Research Society, the Health Physics Society, and the Society of Nuclear Medicine.

Manuscript Instructions for ISRP-12 Proceedings

Accepted abstracts will be published in electronic media (CD or pen-drive) and distributed to every participant. The papers can also be submitted to publication in a special numbered edition of Radiation Physics and Chemistry, being then submitted to the usual process of peer review.

All papers must be submitted directly via the Elsevier RPC EES website

(http://ees.elsevier.com/rpc/default.asp)

until September 30.

Authors must select ISRP-12 when they reach the "Article Type" steps in the submission process.

Please ensure you have read the following instructions and conditions prior to submitting your paper.

Instructions/Conditions of Submission for all papers:

One manuscript per attending author can be submitted.

Maximum of 15 pages per review session manuscript, 6 pages per plenary session manuscript and 3 pages per accepted submitted abstract, all in journal format.

Either LaTeX or Word files are accepted.

Refereeing will commence during the symposium. All contributing authors are expected to complete their reviewing during the conference in order to expedite proceedings.

Papers must be submitted in English and must be linguistically correct.

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What follows is the most recent ISRP-12 Programme and Invited Talks.

For the most up to date information about this Symposium, please refer to the official web site :

http://www.cnen.gov.br/hs_isrp12/

ISRP-12 Programme and Invited Talks

07/10/2012 - Sunday	
16.00	Registration
19.00	Welcome cocktail

08/10/2012 - Monday	
08.45	Welcome Session
09.00	Review Section A - Fundamental processes in radiation physics R.H. Pratt : *Photon absorption and photon scattering - what we don't know and why it matters.*
10:30	**Coffee Break**
11:00	Plenary Lecture B - Quantitative photon and particle analytical techniques D.Creagh: *Radiation based techniques for use in the border protection context*
11:45	Plenary Lecture E: Simulation codes and radiation transport M. Reginatto: *Spectral unfolding techniques and uncertainty estimation*
12:30	**Brunch**
14.00	Review Section G : Medical and biomedical applications G. Royle :
14:45	Plenary Lecture F: Application to material science Jean-Yves Buffiere: *Application of synchrotron radiation for studying damage development in structural materials*
15:30	**Coffee Break**
16:00 to 18.00	Oral Session 1 - Contributed Papers
14:00 to 18:00 - XAFS and developments for the future	**Joint session ISRP/IUCr-CXAFS**
14:00	Yves Joly
14:45	James Hester
15:30	**Coffee Break**
16:00	Matt Newville

../Tuesday and Wednesday

9/10/2012 - Tuesday	
09:00	Review Section G: Medical and biological applications D. Bradley: *Medical and biomedical applications reviewed: Recent hot topics in medical physics*
10:30	**Coffee Break**
11:00	Plenary Lecture F: Application to material science M.H. Tabacniks : *Ion Beam Methods for the Characterization of Materials*
11.45	Review section about Fukushima *Report covering the time past since the event until today*
12:30	**Brunch**
14.00	Round Table Fukushima
15:30	**Poster Session 1 and Refreshments**
16:30	Oral Session 2 - Rooms A and B

10/10/2012 - Wednesday	
09:00	Review Section D: Radiation sources and detectors M.N. Martins : *Electron accelerators: history, applications and perspectives*
10:30	**Coffee Break**
11:00	Plenary Lecture A: Fundamental processes in radiation physics Z. Podolyak: *Exotic nuclei studied with advanced radiation detectors*
11:45	Plenary Lecture : New technologies and industrial applications Birgit Kanngiesser: *BLiX - the Berlin Laboratory for innovative X-ray technologies*
12:30	**Local Tour**

../Thursday and Friday

11/10/2012 - Thursday	
09:00	Review Section C: Absorption and fluorescence spectroscopy J. Roque: *Absorption and fluorescent technics in the Brazilian Synchrotron, past, present and future*
10:30	**Coffee Break**
11:00	Plenary Lectures A and D - Fundamental processes and detectors Arthur Maciel: *The Higgs boson "why and how"*
11:45	Plenary Lecture G: Medical and biomedical applications L. DeWerd: *The calibration of Brachytherapy sources: present and future techniques*
12:30	**Brunch**
14:00	Plenary Lecture D: Radiation sources and detectors P. Fonte: *Resistive plate chambers and related detectors*
14:45	Plenary Lecture I: Cultural heritage and art Joris Dik: *Looking through paintings with portable and synchrotron-based XRF: Revealing hidden paint layers of Vincent Van Gogh and Rembrandt*
15:30	**Poster Session 2 and Refreshments**
16:30	Oral Session 3 - Rooms A and B - Contributed papers
20.00	**Banquet**

12/10/2012 - Friday	
09.00	Plenary Section 1 : Cultural heritage and art M.F. Guerra : *Radiation Physics in the study and authentication of ancient jewelry and coinages*
10:30	**Coffee Break**
11:00	Plenary Lecture C : Absorption and fluorescence spectroscopy R. VanGrieken: *X-ray spectrometry for (preventive) conservation of cultural heritage*
11:45	**CLOSING CEREMONY**

The Future of Nuclear Energy

Following the negative headlines surrounding Fukushima earthquake, tsunami, and nuclear disaster of March 2011, many observers were convinced that nuclear would become a dead technology. At present, nothing could be further from the truth. While a few countries have decided to slow or reverse course, it is projected that many others are expanding their programs as a way to meet their energy and development needs without burning fossil fuels. China, for example, in response to the Fukushima event, has recently adopted new safety standards and will restart approvals for new third-generation plants with the intention of building out an installed nuclear capacity of 70 GW electric by 2020 (presently China has 12 GW).

The International Atomic Energy Agency (IAEA) estimates that global nuclear capacity will grow from 375 GW in 2010 to 429 GW in 2020 and 501 GW in 2030. The August 2011 Edition of "Energy, Electricity and Nuclear Power Estimates for the Period up to 2050" reviews the world's nuclear power capacity, the share of total energy that nuclear provides, global energy needs, and expected growth rates of all of the above. This document is available as a pdf file and may be freely downloaded from:

http://www-pub.iaea.org/books/iaeabooks/8786/Energy-Electricity-and-Nuclear-Power-Estimates-for-the-Period-up-to-2050-2011-Edition

The World Energy Council has recently released a study titled "World Energy Perspective: Nuclear Energy One Year After Fukushima." Their analysis concludes that "nuclear energy will play a full part in the future energy mix provided nuclear safety and at the same time transparency are continuously being reinforced." We reproduce Chapter 4 of this study on the following pages 10 to 18 and the interested reader can access the entire report from:

http://www.worldenergy.org/publications/3863.asp

The Editors

../ World Energy Perspective : Nuclear Energy One Year after Fukushima

World Energy Perspective: Nuclear Energy One Year After Fukushima

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World Energy Council

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4. Changes After the Fukushima Accident

The Fukushima accident prompted an immediate review of the safety of nuclear energy in most countries with nuclear programmes. Many of these countries announced comprehensive safety reviews, which could lead to regulatory changes that would slow or even eliminate plans for expansions of and investments in nuclear power. Even before completing these safety reviews, some countries have decided to close plants that seem particularly risky because of their age or location. More extreme responses include the decision to abandon the use of nuclear energy completely—this includes countries with explicit plans to explore and/or develop nuclear power; others have put their plans on hold. In contrast, several countries (mostly developing countries) have re-affirmed their intentions to develop nuclear power as an important part of their energy mix, or substantially increase nuclear capacity. They are motivated by the need to meet rising power demands efficiently, and/or the desire to reduce dependence on fossil fuels (and quell associated concerns about security of supply and emissions). A summary of these changes can be seen in Table 2.

Of the 31 countries with nuclear energy programmes, those that experienced the most profound public reactions and public policy changes included: Japan, Germany, Italy, and Switzerland.

1. Japan: Before Fukushima, Japan was the world's third-largest producer of electricity from nuclear power. Nuclear energy accounted for about 30% of the country's total electricity production (54 reactors providing 47 GW). The Japanese government had ambitious plans to expand the nuclear component of the country's energy mix to reach 41% of the country's total power supply by 2017, and 53% by 2030 (up from about 29% in 2010). Plans were in place to construct nine new reactors by 2020 and another five by 2030.

The Fukushima accident threw these ambitious long-term plans into doubt, partly because of severe public resistance. Immediately after the accident, the Prime Minister was forced to request that some nuclear reactors in the rest of the country be shut down. In addition, the ongoing construction of reactors has been entirely halted and a new rule has been introduced, requiring that the reactors that were shut down are stress-tested before they are restarted and that they undergo periodic inspections. In addition, Fukushima Daiichi Units 1 to 4 were to be decommissioned; the government also announced immediate measures to boost nuclear safety, as well as plans to undertake a stringent safety assessment at each reactor to check its capacity to withstand extreme natural events.

By mid-February 2012, only two of Japan's nuclear power reactors were in operation, while the remaining 48 reactors were shut for periodic inspections, unplanned inspection, or even anticipated decommissioning. Since Fukushima, all Japan's nuclear reactors have been undergoing two-phase stress tests at the direction of the Japanese government. The first phase (to determine whether the plants can withstand large earthquakes and tsunamis) is carried out while reactors are offline for periodic inspections. This effectively means that all plants that have entered scheduled maintenance outages since the accident

Table 2

Nuclear Energy Policy Changes After Fukushima (as of January 2012)

Source: IAEA for "Nuclear Electricity Generation", "Reactors Operable", "Reactors under Construction"; WNA: for "Reactors Planned" and "Reactors Proposed"

1 Countries with "**existing**" nuclear installations:	
Use of nuclear power in principle **not being contested**[1]	Argentina, Armenia, Belgium[2], Brazil, Bulgaria, Canada, China, Czech Republic, Finland, France, Hungary, India[3], Iran, Mexico, Netherlands, Pakistan, Romania, Russia, Slovakia, Slovenia, South Africa, South Korea, Spain, Sweden, Taiwan, Ukraine, United Kingdom, United States
Use of existing nuclear power **being contested**	**Japan**[4]
Use of existing nuclear power **being phased-out**	**Germany**[5], **Switzerland**[6]
2 Countries "**currently constructing**" new nuclear installations:	
Construction projects **not being contested**[7]	Argentina, Brazil, Bulgaria, China, Finland, France, India, South Korea, Pakistan, Russia, Slovakia, Taiwan, Ukraine, United States
Construction projects **cancelled, scaled-back or delayed**	**Japan**
3-Countries with "**plans and/or proposals to construct**" new nuclear installations:	
Plans/proposals for new constructions **not being contested**	All 31 countries mentioned in Table-3 (see below) except Germany, Switzerland, Italy
Plans/proposals for new constructions **prohibited**	**Germany, Switzerland, Italy**[8]

Notes:
1) Assessing safety installations and incorporating lessons learned
2) Government is expressing concern about the feasibility of implementing a phase-out.
3) The public response and protests taking place at Kudankulam-1 (still under construction), suggest there may be further protests, and potentially a government response, especially given the democratic regime.
4) Clarifications to come in an update to the Japan's Strategic Energy Plan (expected 2012)
5) Immediate suspension of eight nuclear installations following Fukushima, and phased-out closure of remaining power plants as fast as possible
6) Expected closure of five nuclear power plant units between 2019 and 2034
7) Partial modification of safety standards or licensing procedures
8) Effective construction bans existed in Germany before Fukushima. These bans were being revisited as part of the "nuclear renaissance", but Fukushima halted or reversed these developments reversed this direction. In Italy, a referendum in June 2011 imposed a permanent ban on the reintroduction of a nuclear power programme.

cannot resume operations, until they get government approval. Tests have now been completed at a number of plants, and Japan's nuclear safety regulator, the Nuclear and Industrial Safety Agency, recently endorsed the findings from the first units to complete the tests (Kansai's Ohi 3 and 4), although the plants are still awaiting permission to restart.

In October 2011, the government published a white paper confirming that Japan's dependency on nuclear energy will be reduced as much as possible in the medium and long term. In fact, these long-term plans may include deploying more renewable energy, as well as stepping-up measures to improve energy efficiency and to encourage cleaner use of fossil fuels. The new energy policy will be developed by mid-2012. In addition in mid-2011, a decision was made to set up a new independent nuclear regulation agency under the Environmental Ministry. The new agency will be launched in April 2012, combining the role of Nuclear and Industrial Safety Agency (NISA) and Nuclear Safety Commission (NSC). This reorganisation will create an entity responsible for regulating nuclear power generation, which is separate from the entity that is promoting it.

The government will also establish a nuclear safety investigation committee responsible for overseeing the new nuclear regulatory agency, and give it legal power to conduct hearings and onsite inspections—essential for investigating the cause and damage of nuclear accidents. By the end of 2012, the Federation of Electric Power Companies of Japan will establish an independent organisation to study nuclear safety measures. As cooperation with relevant foreign organisations is essential in order to enhance the effectiveness of the new organisation, on February 2012, the federation agreed to coordinate with the US Institute of Nuclear Power Operations.

2. Germany: Outside Japan, the most significant impact of the Fukushima accident has been in Germany. In 2010, the country had 17 reactors operating, with a total gross capacity of 20 GW, providing about 23% of the country's electricity. Within days of the accident, and in an unexpected response, the German government ordered the suspension of operations at seven of its older nuclear plants (operational before 1980), and decided that another, older plant, which was temporarily offline due to technical reasons, should not be restarted.

In May 2011, the government followed with a decision to abandon completely the use of nuclear power by 2022. Eight facilities will be closed permanently, while the country will be phasing out its remaining nine nuclear power plants gradually: one plant each in 2015, 2017, and 2019, respectively; three plants in 2021, and three plants in 2022. This phase-out plan ensures shutting down the remaining nuclear power capacities without running into critical system instabilities. It will also lead to an average plant lifetime of approximately 30 years under such a phase-out plan. The German decision to phase-out nuclear by 2022 will constitute a challenge to its energy mix. It will also affect the energy system in Europe, since it will mean that more intermittent power output will have to be delivered to Germany, and more electricity will be traded across borders; gas-powered plants are expected to be brought online to balance the system. This will have price implications for both the European electricity and gas markets, but the nature of this is currently unknown.

3. Italy: Responses in other countries have varied. In Italy, the government has decided to scrap its previous plans to reintroduce nuclear-generated electricity. A referendum in June 2011 imposed a permanent ban on the reintroduction of a nuclear power programme.

4. Switzerland: In Switzerland, the government announced its intention to decommission its five nuclear power plants gradually between 2019 and 2034. The Swiss phase-out will be organised according to the safety of the operating plants, and is expected to lead to a total lifetime of about 50 years for each plant. In addition, Switzerland has suspended the licensing under discussion for three new nuclear power plants.

In other countries, many governments seem to be standing by their use of nuclear energy, at least in principle. Some of these countries already have nuclear power, while others are about to acquire it. These countries' decisions to uphold their nuclear

Table 3

Summary of Recent Developments on Nuclear Power in Different Countries

Source: WNA, IEA, WEC

	Operable Nuclear Capacity January 2012 (MWe)	Policy Announcements and Actions Relating to Nuclear Power (March 2011 and-February 22, 2012)
European Union	122,411	Announced plans to stress test all plants in its 27 countries. Each country is responsible for its specific programme.
United States	101,240	Continues to support nuclear power while stressing safety as paramount concern.
France	63,130	Continues to support nuclear power while carrying out European Union stress test and looking to increase the role of renewables.
Japan	44,102	Wrote-off Fukushima Daiichi Units 1-4, which are to be decommissioned. All remaining nuclear reactors have been undergoing two-phase stress tests. Announced a review of the existing plan for nuclear power. The new energy policy will be developed by mid-2012.
Russia	23,643	Affirmed plan to double nuclear capacity by 2020 while undertaking comprehensive safety review.
South Korea	19,675	Affirmed plan to continue expansion of the nuclear industry and to conduct safety checks.
Ukraine	13,107	Plans to maintain nuclear share in electricity production to 2030, which involves substantial new builds.
Canada	12,569	Plans to expand its nuclear capacity over the next decade by building more new reactors.
Germany	12,068	Immediately shut reactors operational before 1980 and announced that all other reactors would be closed by 2022.
China	11,688	Temporarily suspended approval of new nuclear reactors, but affirmed 12th Five-Year Plan target to start construction of an additional 40 GW of nuclear capacity in the period 2011–2015.
United Kingdom	9,920	Affirmed commitment to nuclear power by announcing plans to build eight new reactors by 2025.
Sweden	9,304	The government is working with the utilities to expand nuclear capacity to replace the 1200 MWe lost in closure of Barsebäck 1 and 2.
Spain	7,567	Government commitment to the future of nuclear energy in Spain has been uncertain, but is firming up.
Belgium	5,927	Little government support for nuclear energy. The government is expressing concern about the feasibility of implementing the phase out.
Taiwan	5081	Plans to expand its nuclear capacity, with two new reactors under construction.
India	4,391	Affirmed plans to boost nuclear capacity to 63 GW by 2032 and to review safety.
Czech Republic	3,678	Affirmed plans to build two new units at its Temelin nuclear power station.
Switzerland	3,263	Announced plans to close its five nuclear reactors by 2034.
Finland	2,736	Affirmed plans to build nuclear power station at Pyäjoki.
Bulgaria	1,906	Affirmed plans to build two nuclear power station (2 x 1000 MW reactors) at Belene.
Brazil	1,884	Plans to build two new nuclear plants in the northeast and two more near Angra in the southeast are underway.
Hungary	1,889	Parliament has expressed overwhelming support for building two new power reactors.
Slovakia	1,816	Government commitment to the future of nuclear energy is strong.

	Operable Nuclear Capacity January 2012 (MWe)	Policy Announcements and Actions Relating to Nuclear Power (March 2011 and-February 22, 2012)
South Africa	1,800	Affirmed commitment to nuclear power by confirming 9.6 GW by 2030.
Mexico	1,300	Some government support for expanding nuclear energy to reduce reliance on natural gas, but recent low gas prices may undermine this.
Romania	1,300	Affirmed no change to constructing Cernovada 3 and 4 (2 x 720 MW).
Argentina	935	Government commitment to the future of nuclear energy is strong.
Iran	915	Affirmed commitment to nuclear power by starting up Bushehr on 8 May 2011.
Pakistan	725	Government commitment to the future of nuclear energy is strong.
Slovenia	688	Nuclear power plant at Krsko (operated 1983) operational life was designed to be 40 years, but a 20-year extension is being sought.
Netherlands	482	Public and political support is increasing for expanding nuclear energy.
Armenia	375	Has one reactor in operation and the government has approved a joint venture to build another by 2018.
Saudi Arabia	Planning 20,000	Affirmed that using nuclear power is under consideration.
Poland	Planning 6,000	Affirmed plans to commission its first reactor by 2025.
UAE	Planning 5,600 Proposing 14,400	Affirmed no change to plans to build their first nuclear power plants.
Turkey	Planning 4,800 Proposing 5,600	Affirmed no change to plans to commission the first of four planned reactors of 1.2 GW by 2018.
Vietnam	Planning 4,000 Proposing 6,700	Affirmed no change to plans to build their first nuclear power plants.
Belarus	Planning 2,000 Proposing 2,000	Government commitment to the future of nuclear energy is strong.
Bangladesh	Planning 2,000	Government commitment to the future of nuclear energy is strong.
Indonesia	Planning 2,000 Proposing 4,000	Delayed, its first nuclear power plant project until after 2020: the government has not yet taken the decision to build a nuclear power plant..
Lithuania	Planning 1,350	Government commitment to the future of nuclear energy is strong.
Egypt	Planning 1,000 Proposing 1,000	The new government has not made any statements about its plans for the El Dabaa plant.
Jordan	Planning 1,000	Government commitment to the future of nuclear energy is strong.
Kazakhstan	Planning 600 Proposing 600	The government is considering future options for nuclear power.
Italy	Proposing 17,000	A referendum in June 2011 imposed a permanent ban on the reintroduction of a nuclear power programme.
Thailand	Proposing 5,000	Delayed its first nuclear power plant projects until after 2020.
Chile	Proposing 4,400	On March 21, 2011, signed a nuclear power cooperation agreement with the USA.
Malaysia	Proposing 2000	The government is considering future options for nuclear power.
Israel	Proposing 1,200	Plans to develop nuclear plant with Jordan most likely will not proceed.
North Korea	Proposing 950)	Is not currently considered to have serious intentions to deploy nuclear power for electricity.

Table 4

World Nuclear Power Reactors as of 22 February 2012

Source: IAEA: for “Nuclear Electricity Generation”, “Reactors Operable”, and “Reactors under Construction” ; WNA: for “Reactor Planned” and “Reactors Proposed”

Country	Reactors Operable February 22, 2012		Under Construction February, 22 2012		Reactors Planned February 2012		Reactors Proposed February 2012	
	No.	MWe	No.	MWe	No.	MWe	No.	MWe
Argentina	2	935	1	692	2	773	1	740
Armenia	1	375			1	1,060		
Bangladesh					2	2,000		
Belarus					2	2,000	2	2,000
Belgium	7	5,927						
Brazil	2	1,884	1	1,245			4	4,000
Bulgaria	2	1,906	2	1,906	2	1,900		
Canada	18	12,624			3	3,300	3	3,800
Chile							4	4,400
China	16	11,688	26	26,620	51	57,480	120	123,000
Czech Republic	6	3,766			2	2,400	1	1,200
Egypt					1	1,000	1	1,000
Finland	4	2,736	1	1,600			2	3,000
France	58	63,130	1	1,600	1	1,720	1	1,100
Germany	9	12,068						
Hungary	4	1,889					2	2,200
India	20	4,391	7	4,824	17	15,000	40	49,000
Indonesia					2	2,000	4	4,000
Iran	1	915			2	2,000	1	300
Israel							1	1,200
Italy							10	17,000
Japan	50	44,215	2	2,650	10	13,772	5	6,760
Jordan					1	1,000		
Kazakhstan					2	600	2	600
Korea North							1	950
Korea-South	23	20,671	3	3,640	6	8,400		
Lithuania					1	1,350		
Malaysia							2	2,000
Mexico	2	1,300					2	2,000
Netherlands	1	482					1	1,000
Pakistan	3	725	2	630	1	340	2	2,000
Poland					6	6,000		
Romania	2	1,300			2	1,310	1	655
Russia	33	23,643	10	8,203	14	16,000	30	28,000
Saudi Arabia							16	20,000
Slovakia	4	1,816	2	782			1	1,200
Slovenia	1	688					1	1,000
South Africa	2	1,830					6	9,600
Spain	8	7,567						
Sweden	10	9,320						
Switzerland	5	3,263					3	4,000
Taiwan (China)	6	5,081	2	2,600	1	1,350		
Thailand							5	5,000
Turkey					4	4,800	4	5,600
Ukraine	15	13,107	2	1,900	2	1,900	11	12,000
UAE					4	5,600	10	14,400
UK	18	9,920			4	6,680	9	12,000
USA	104	101,240	1	1,165	11	13,260	19	25,500
Vietnam					4	4,000	6	6,700
WORLD	437	370,402	63	60,057	161	178,995	334	378 ,905

Note:
Operating = Connected to the grid
Building/Construction = First concrete for reactor poured, or major refurbishment under way;
Planned = Approvals, funding or major commitment in place, mostly expected in operation within 8–10 years;
Proposed = Specific programme or site proposals, expected operation mostly within 15 years.

plans are motivated by the economics of nuclear power compared to other forms of electricity generation, rising demand for electricity, and the need to reduce dependency on fossil fuels, while addressing concerns surrounding security of supply and climate change.

Table 3 gives an overview of policy announcements and actions relating to nuclear power between the Fukushima accident and February 22, 2012. More details are included in the Appendix to this report.

These policy and investment changes and announcements indicate that there are few major changes in the status of global nuclear power (see Table 4). The WEC's canvass of Member Countries revealed figures different from those included in Table-4 and they came from Bulgaria, Canada, Finland, Japan, Hungary, Italy, Romania, Russia, Saudi Arabia, South Korea, Switzerland, Ukraine, and USA.

In a survey conducted by WEC, the above statistics included in Table-4 were confirmed except for the following:

- Bulgaria reported no reactors under construction. The construction of two reactors was suspended in the 1990s. The government and parliament still need to take the final decision whether to resume, change the site (Kozloduy instead of Belene) or stop construction.
- Canada reported 17 operable reactors, three reactors under construction, two planned and one proposed.
- Finland reported two planned and none proposed. Two new units are in the "planning phase" and are expected to be operational within 8–10 years. These reactors have also been approved by the parliament, which is the most significant hurdle for new units.
- Japan reported 54 operable reactors and seven planned.
- Hungary reported none proposed.
- Italy reported none proposed.
- Romania reported two proposed.
- Russia reported 10 planned and 20 proposed.
- Saudi Arabia reported that using nuclear is still under consideration and that the WNA figures given above are speculative.
- South Korea reported 21 operable reactors and seven reactors under construction.
- Switzerland reported that the licensing procedure for three proposed reactors has been suspended since Fukushima.
- Ukraine reported no reactors under construction and six proposed.
- The USA reported seven planned and 27 proposed.

The net changes in the number of nuclear reactors worldwide, summarised below in Table 5, show that the major changes included 13 reactors exiting service (eight in Germany, four in Japan, and one in the UK), while eight reactors entered service (three in China, one in Iran, two in South Korea, one in Pakistan, and one in Russia). As for

Table 5

Net Changes in the Number of Reactors (March 10, 2011 and February 22, 2012)

	Operating	Under Construction	Planned	Proposed
China	3	-1	1	10
Germany	-8			
India		2	-1	
Iran	1	-1		
Japan	-4		-2	4
Korea-South	2	-2		
Lithuania			1	-1
Malaysia				1
Pakistan	1	1	-1	
Russia	1	-1		
Saudi Arabia				16
Ukraine				-9
United Kingdom*	-1			
USA			2	-4
Vietnam			2	-6

*On October 24, 2011, Magnox Ltd. announced that Unit 1 at Oldbury nuclear power plant would be permanently shut down in February 2012 (10 months earlier than expected) after 44 years of operation.

construction, five reactors were completed (one in China, one in Iran, two in South Korea, and one in Russia), while construction started on three reactors (two in India, and one in Pakistan). As for reactors in the planning stages, four reactors were dropped (one in India, two in Japan, and one in Pakistan), while six more were added (one in China, one in Lithuania, two in the USA, and two in Vietnam).

Calendar

2012

30th September - 4th October, 2012

Eighth International Conference on Atomic and Molecular Data and Their Applications (ICAMDATA 2012)

Washington DC, USA

Full information on pages 20 to 21 of the April 2012 Bulletin

7th - 12th October, 2012

12th International Symposium on Radiation Physics

Rio De Janiero, Brazil

Full information and registration form on pages 15 to 17 of the April 2012 Bulletin
and further information on pages 6 to 9 of this Bulletin

25th - 28th November, 2012

11th Radiation Physics and Protection Conference

Ismailia, Egypt

Full information and registration form on pages 18 and 19 of the April Bulletin

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INTERNATIONAL RADIATION PHYSICS SOCIETY

The primary objective of the International Radiation Physics Society (IRPS) is to promote the global exchange and integration of scientific information pertaining to the interdisciplinary subject of radiation physics, including the promotion of (i) theoretical and experimental research in radiation physics, (ii) investigation of physical aspects of interactions of radiations with living systems, (iii) education in radiation physics, and (iv) utilization of radiations for peaceful purposes.

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The **IRPS Bulletin** is published quarterly and sent to all IRPS members.

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